Blockchain for Verification and Storage of Academic Credentials to Prevent Academic Credential Fraud: A Systematic Literature Review

Nyingye Metog Dorji[1], Dorji Wangmo[2*], Sonam Dechen Lhaki[3], Dawa Tshering[4] , Kezang Dema[5]

Computing Technologies Department, College of Science and Technology, Royal University of Bhutan,
E-mail:02220158.cst@rub.edu.bt[1],02220145.cst@rub.edu.bt[2], 02220169.cst@rub.edu.bt[3],
02210194.cst@rub.edu.bt[4],kezangdema.cst@rub.edu.bt[5]

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Abstract

Academic fraud includes the falsification of academic credentials, which damages the image of educational institutions and impacts labor in the marketplace worldwide. As much as digital credentialing reduces forgeries, a centralized system will always have vulnerabilities and counterfeiting and data security risks. This paper uses a systematic literature review that explores blockchain-based solutions for storing and verifying the authenticity of higher education academic institutions' credentials. It looks into related research published from 2020 to 2025 and follows PRISMA guidelines involving the screening of 144 studies and results in a full-text review of 30 studies. The review involves comparing blockchain-based systems in use and conducting an assessment of their effectiveness, scalability, and real-world applications. Then the data derived are analyzed through three themes, which present blockchain technologies that are widely used in educational systems, whether these technologies are applicable to be locally implemented in Bhutan, and the use cases and functional applications. From these extracted themes, findings such as the benefits, consequences, and comparison of traditional means to the blockchain applications have been derived and discussed thoroughly in this paper. Some critical findings include 74% of the studies having the potential to be implemented locally and Ethereum and Smart Contracts being commonly used platforms, representing 45% and 21% of studies, respectively.

Key Words: *Blockchain, Academic Credentials, Academic Credential Storage, Academic Credential Fraud, Systematic Literature Review.*

1. INTRODUCTION

In today's digital age, there is a considerable surge in academic fraud and certificate falsification crimes, compromising the credibility of educational institutions and impacting the labor market. Therefore, blockchain technology provides a promising solution by allowing decentralized and tamper-proof ledgers for storing and verifying academic credentials. Blockchain is a distributed ledger technology that allows secure, immutable and decentralized transactions and does not rely on third parties (Zheng et al., 2017). The concept is applied in academic credential verification as well. This research aims to conduct a systematic review of blockchain-based solutions proposed in various literature for preventing academic credential fraud and answer three research questions.

Research Questions:

A. How does the use of Blockchain technology in academic credential verification compare to existing anti-fraud methods in preventing credential fraud in higher institutions?
B. What are the consequences and benefits associated with the adoption of blockchain technology in the field of education?
C. What are the widely used blockchain technologies, frameworks, and real-world solutions used in order to create a system to verify and store credentials?

2. BACKGROUND

The advancement of technology has raised concerns in areas such as education and it especially raises concerns about academic credential fraud. Credentials (transcripts and degree certificates) are intended to serve as proof of professional qualification (Johnston & Oswald, 1998; Kabashi et al., 2024). However, fake degrees from degree mills or mistranslations, which are common origins of fake academic credentials (Grolleau et al., 2008; Delgado-Von-Eitzen et al., 2021) has become an increasing concern for higher

education institutions worldwide and all of these weaken the trust in educational qualifications (Eaton et al., 2023), which can be dangerous when unqualified individuals hold important positions.

This caused a movement towards digital credentialing, but centralized systems have the same vulnerabilities. Therefore, Blockchain is a potential solution, as it offers a decentralized, immutable and verifiable record (Harika et al., 2024). Examples of relevant pilot projects include MIT's Blockcerts and the Maltese Education Blockchain, which demonstrate useful practical potential, but uncertainty exists around costs, legal implications (e.g: GDPR) and general resistance from conventional institutions (Wang et al., 2020), all of which limit widespread adoption.

3. RELATED WORKS

In order to visualize and estimate the approximate number of literature required for the study, the following three papers were referred as given in Table 1.

Table. 1: *Related Works referred to visualize the number of literature needed*

Sl. no	Study Name	Authors	Source	Year	Number of Literature Identified	Number of Literature Included
1	A Systematic Literature Review on Blockchain-Based Systems for Academic Certificate Verification	Avni Rustemi, Fisnik Dalipi, Vladimir Atanasovski,(Senior Member, Ieee), Aleksandar Risteski (Member, Ieee)	IEEE Access	2023	1744	34
2	A systematic review on blockchain-based access control systems in cloud environment	Aarti Punia1 , Preeti Gulia , Nasib Singh Gill1 , Ebuka Ibeke, Celestine Iwendi and Piyush Kumar Shukla	Springer Open	2024	641	118
3	A Systematic Review of Blockchain Applications	Farhana Akter Sunny; Petr Hajek; Michal Munk; Mohammad Zoynul Abedin; Md. Shahriare Satu; Md. Iftekharul Alam Efat	IEEE Access	2022	7819	765

The first paper is used as a primary reference in terms of how to structure this review, while the other two papers were referred to look into the choice of databases, screening methods, data extraction processes, and the number of papers identified and included in their final analysis. Even though these three papers comprehensively reviewed the blockchain-based academic certificate verification systems, the papers focused fundamentally on global technological developments without analyzing the practical applicability of these solutions within developing countries or Bhutan's higher education system. These studies address that gap by integrating recent research while examining the practical challenges, opportunities, and important considerations for implementation in Bhutan. The findings therefore give insights that are content specific which can guide policymakers and educational institutions considering blockchain adoption.

4. RESEARCH DESIGN

4.1 Procedure

The research adopted a systematic review methodology, which ensures systematic collection, evaluation, and synthesis of relevant literature in order to contribute to the scarce study of blockchain in Bhutan.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adopted to create the search strategy, screening, and selection processes. And it included four steps which involved identification, screening, eligibility, and inclusion/exclusions. The review had undergone two stages of screening. In the first stage screening, from 144 research papers and after duplicate removal, 137 records remained for title and abstract screening. The papers had then gone through individual screening processes and the which reduced the number of included papers to 63 papers as shown in Fig.1.

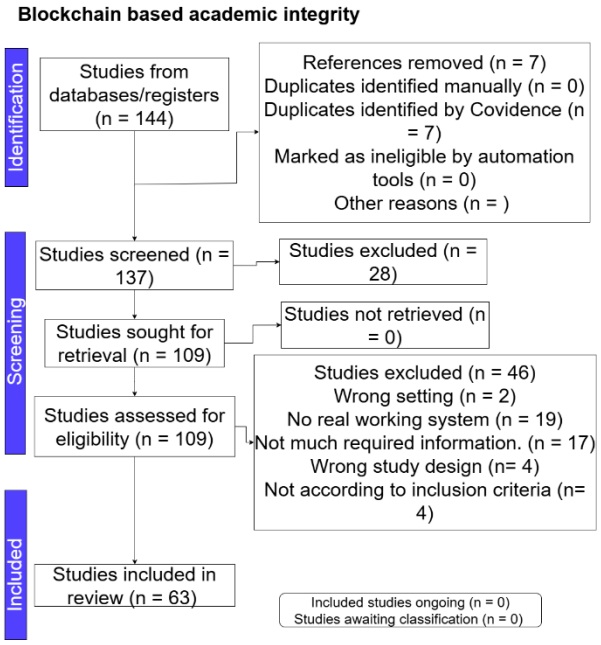

Fig.1: *PRISMA Flow chart for First stage of paper Screening.*

In the second stage, all 63 papers from the previously selected PRISMA approach were read and then only the 30 papers were included for further data extraction as depicted in Fig. 2.

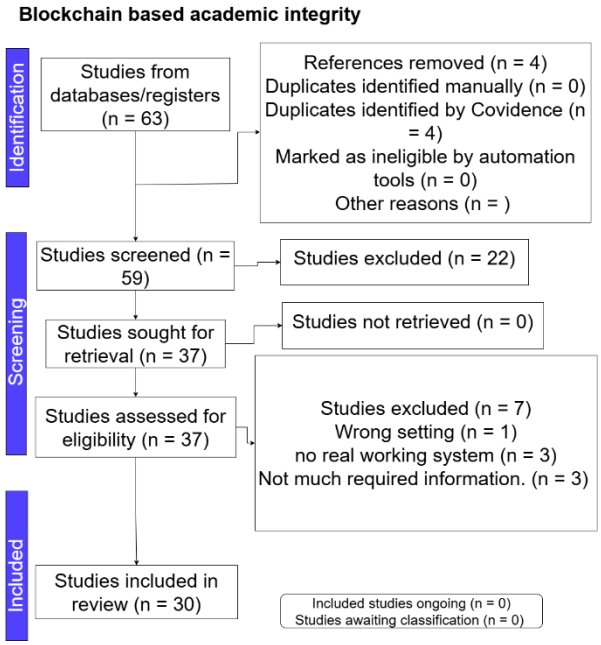

Fig. 2: *PRISMA Flow chart for the second stage of paper Screening.*

4.2 Eligibility Criteria

The inclusion and exclusion criteria define the type of literature that will be included in the research. All selected literature had gone through the following criteria:

Inclusion Criteria:

A. Studies focused on blockchain technologies that give solutions for academic credential storage and fraud prevention.
B. Studies that have implemented blockchain technology in educational institutions.
C. Studies involving any stakeholder in the academic credential ecosystem, not limited to educational institutions, that analyze and explore blockchain-based systems for validation, generation or management of academic qualifications.
D. Studies published in English which were published within the years 2020 – 2025.
E. Open-access literature that is available online in high-quality databases.
F. Peer-reviewed articles and journals, gray literature, conference papers, and project papers from other sources.

Exclusion Criteria:

A. Studies that are not related to blockchain or academic credential fraud.
B. Studies that have not used blockchain models that propose a solution to academic credential

fraud.

C. Studies that are purely theoretical (opinion or viewpoint).
D. Studies with blockchain applications in other sectors
E. Studies published before 2020 were not considered unless the study is highly relevant and foundational.

4.3 Search Strategy and Data Collection

The literature was collected from online research databases such as *IEEE Xplore, SpringerLink, ACM Digital Library, and Science Direct,* which are considered high-quality databases. Some other databases, such as *Google Scholar* and *ResearchGate,* which provided access to a lot of papers published, were also considered as supplementary search sources. The search strings used are displayed in Table 2.

Table 2: *Search Strings structure for searching in databases*

("BLOCKCHAIN")
AND
("ACADEMIC CREDENTIAL" OR "ACADEMIC CERTIFICATE" OR "DEGREE CERTIFICATE")
AND
("FRAUD PREVENTION" OR "VERIFICATION" OR "STORAGE")

Covidence was used between four independent reviewers to screen all the studies and any disagreements regarding study selection had been resolved through discussion and consensus among the reviewers. Table 3 illustrates that a total of 137 papers from various repositories has been accepted as relevant studies for further screening and full text review from a total of 144 papers

Table 3: *Number of studies selected from each database from each year*

Year	ACM DL	IEEE	Science Direct	Springer	ResearchGate	Google Scholar	Total
2020	1	0	4	7	3	7	22
2021	0	6	2	4	7	4	23
2022	0	3	5	8	11	3	30
2023	0	4	6	5	10	2	27
2024	0	2	3	3	9	10	27
2025	0	2	1	1	3	1	8
Total	1	17	21	28	43	27	137

4.4 Selection of Relevant Studies

The selection of relevant studies was done by first looking into the abstract, titles, and keywords which were highly relevant to the review, and then a full-text review was carried out on all those papers, and a total of 63 papers were selected. Then again, after reaching consensus with the reviewers, a total of 30 out of 63 papers were selected. Therefore, a total of 30 papers out of 144 papers were selected as the relevant studies to extract data, and Figure 3 clearly illustrates that most of the papers related to this study are published more in IEEE Xplore, followed by Researchgate, Science Direct and Springer.

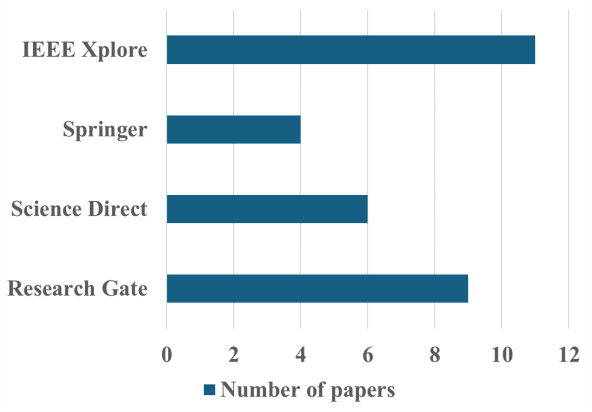

Fig. 3: *Papers published in online academic repositories.*

4.5 Study Risk of Bias Assessment

A risk of bias assessment had been conducted according to the Critical Appraisal Skills Programme (CASP) checklist, which is used to critically assess a research study's validity, reliability, and relevance. All of the authors here have assessed the quality of the paper and derived a mutual consensus and concluded that the majority of the papers were moderate to high quality papers with a clear aim and objectives, and addressing key areas that were aligned with this research study and most of the papers are identified to be technical, which suggests a strong focus on the relevance and practical application in the field of blockchain-based academic credentials.

4.6 Data Extraction

For this research study, the following types of data were extracted from each study: Country, Study Aim, Study Setting, Blockchain Platform used, Blockchain Application, Traditional Anti-Fraud Methods, Benefits of using Blockchain in this Study, and Intervention. These data had been collected in one Excel sheet, and the following analysis had been done.

4.7 Data Analysis

Studies according to the source of continent: Fig. 4 illustrates the geographic distribution of the studies based on the continent of the corresponding authors or study origin

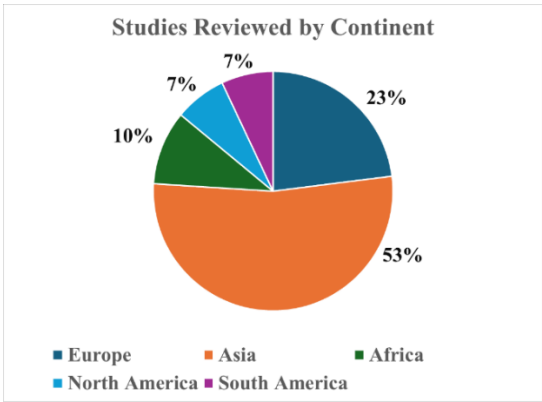

Fig.4: *Distribution of Studies according to the continent of origin.*

4.7.1 Number of studies retrieved from different databases

The graph, as illustrated in Fig.5 shows the distribution of research studies sourced from various academic databases.

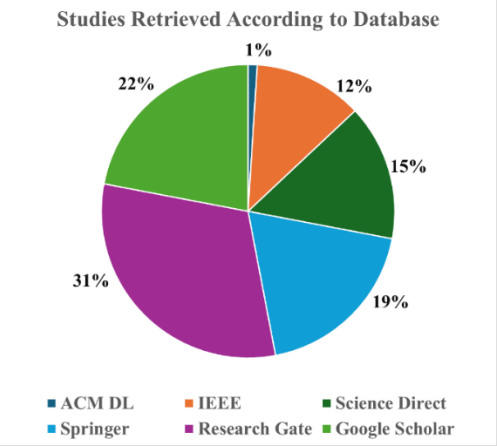

Fig. 5: *Distribution of Studies retrieved according to Database.*

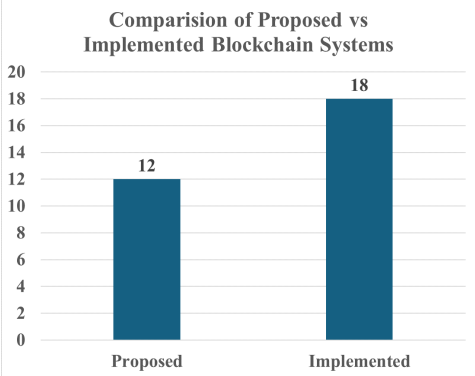

Fig. 6: *Number of Proposed or Implemented Systems from Studies.*

4.7.3 Blockchain platform used

The Fig. 7 presents the distribution of different blockchain platforms employed across the selected studies. It illustrates that the leading platform preferred is Ethereum, followed by Smart Contracts

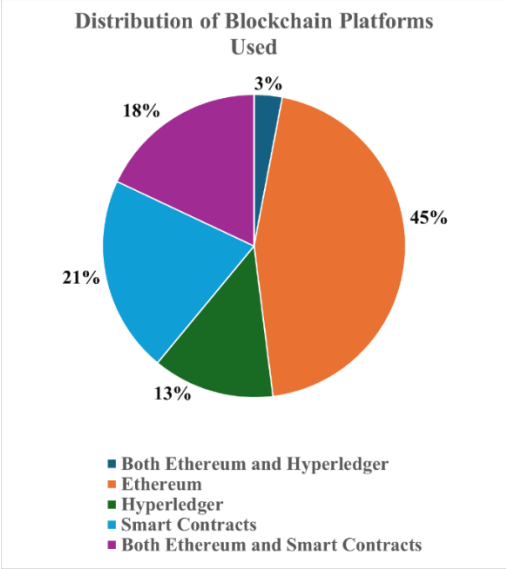

Fig. 7: *Distribution of Blockchain Platforms Used*

5. THEMATIC ANALYSIS

Thematic analysis refers to a form of pattern recognition for recognizing core themes by reading and rereading the available materials. After a series of reading and rereading and a joint meeting among the authors, three significant themes were formulated

5.1 Theme1: Types of Blockchains

There are many types of blockchains, such as private, public, and consortium. There were also

some studies where two types of blockchains were combined, while for some, none were mentioned. The keywords such as 'Hybrid' and 'Unspecified' were used to describe such cases. In our SLR, it was found that 50% of the studies recommended public blockchain, while 16.7% recommended private blockchain, and only 3.3% recommended consortium blockchain, with the rest being hybrid or unspecified blockchain. Fig. 8 depicts the statistics in the form of a pie chart.

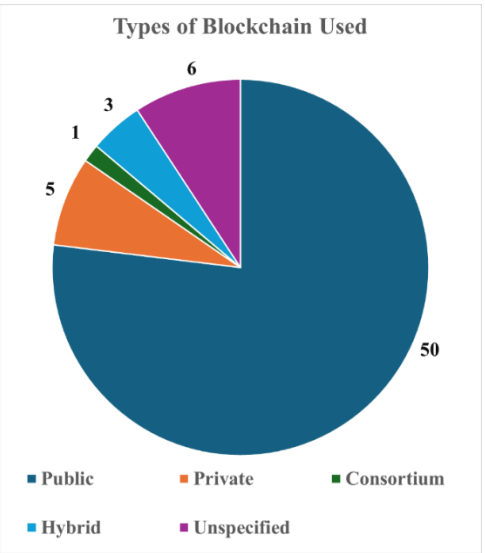

Fig. 8: *Distribution of Types of Blockchain Used.*

5.2 Theme 2: Local Applicability

The next theme includes the local applicability of the proposed or implemented system. For this study, the authors looked into whether the system that was proposed or implemented can be applied in our locality by factoring in government policies, institutional practices, educational structure, and technological readiness. The results showed that 74% of the systems proposed or implemented in their studies were scalable and could be applied locally shown as 'Yes', 23% of the systems had the potential to be applied locally but were not ready yet shown as 'Maybe', and 3% of the systems were not applicable and could not be implemented locally shown as 'No' as depicted in Fig. 9.

5.3 Theme 3: Use Case and Financial Applications

The third theme considered was the use cases and functional applications. Five subthemes were considered, namely- Academic Credential Verification (ACV), Timestamping and Record Immutability (TRI), Plagiarism Detection and Prevention (PDP), Digital Identity and Student Authentication (DISA), and Smart Contracts for Course Completion (SCCC). These themes represent the core functional application of blockchain technology in the education system. Each subtheme addresses a specific challenge faced in institutions that blockchain technology can help improve or solve. Fig. 10 depicted below shows the number of 'Yes' responses for each of the aforementioned subthemes in regard to each of the studies.

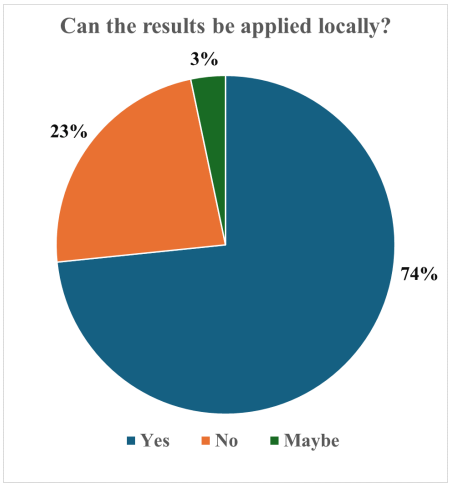

Fig. 9: *Visualization of local applicability*

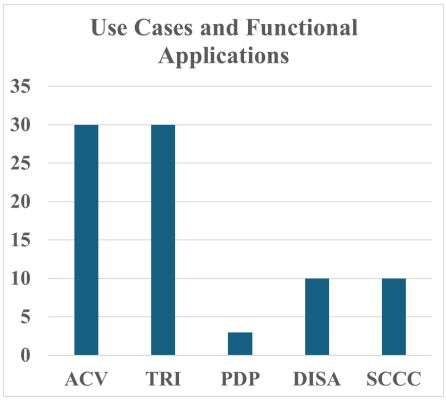

Fig. 10: *Number of 'Yes" for each subtheme*

6. RESEARCH FINDINGS

6.1 Research Question 1

RQ1: How does the use of Blockchain technology in academic credential verification compare to existing anti-fraud methods in preventing credential fraud in higher institutions?

Academic credential verification has been revolutionized by blockchain. It has brought about

significant improvements compared to those traditional methods like paper-based records, centralized databases, third-party verifications, digital signatures, and e-portal systems. These traditional methods are often associated with problems such as high cost, vulnerability to fraud, dependence on centralized authorities, inefficient paperwork, and slow processing. While blockchain-based systems offer advantages including immutability, decentralization, security, transparency, tamper-proof storage, faster verification, and cost-effectiveness, making them highly effective and efficient in combating credential fraud in higher education institutions.

6.2 Research Question 2

RQ2. What are the consequences and benefits associated with the adoption of blockchain technology in the field of education?

Considering the benefits of blockchain despite some of its challenges, adopting blockchain in higher education has been an important step. Studies portray the improvement in security, verifiability, transparency, trust, integrity, maintaining a tamper-proof record, reduced administrative burden, efficiency, and fraud prevention due to blockchain's immutable and decentralized nature. These benefits are applicable not only to diploma and certificate management but also to academic transcripts, credit systems, and maintaining broader educational records. However, there still are challenges like high gas fees on public blockchains, regulatory issues such as GDPR compliance, institutional resistance, scalability, interoperability because of a lack of standardization, and the digital divide. Regardless of these challenges, blockchain remains a promising solution with substantial potential to enhance educational systems.

6.3. Research Question 3

RQ3. What are the widely used blockchain technologies, frameworks, and real-world solutions used in order to create a system to verify and store credentials?

According to the data analysis from the selected papers, Ethereum and Smart Contracts are the commonly used blockchain platforms, representing 45% and 21% of studies, respectively. Ethereum is favored for its smart contract abilities, as witnessed in MIT Blockcerts, Cerebus (Tariq, 2023), and CredChain (Ahmed et al., 2024). Smart contracts are preferred for automated issuance and verification (Rane et al., 2020), IPFS for off-chain storage to reduce gas fees (Sultana, 2023), and ZKPs for privacy-preserving verification (Tan-Vo, 2024). Universities like UTM-BADVES prefer Hyperledger Fabric, a permissioned blockchain (Azli et al., 2023), because of its privacy controls, despite requiring institutional collaboration. The implementation in the real world portrays the potential of blockchain in verifying credentials and preventing fraud; however, success depends on hybrid models, institutional partnerships, and scalable, low-cost solutions. For its recommendations, the factors to be included are: (i) cost efficiency through Layer 2 or private chains; (ii) privacy compliance using ZKPs/IPFS; (iii) user adoption through mobile wallets like MetaMask; and (iv) interoperability through W3C verifiable credentials.

7. CONCLUSION

The study has presented a systematic literature review of blockchain-based solutions aimed at tackling credential fraud by providing secure, tamper-proof, and verifiable storage systems. The findings indicate that blockchain emerges as a compelling technological intervention capable of restoring trust in credential verification systems. However, blockchain implementations face critical barriers, including high gas costs, data privacy conflicts, lack of regularity clarity, and resistance from traditional verification systems. A critical finding shows that 74% of the selected studies have the potential to be applied locally with appropriate policy and infrastructure support. Further studies can be done to integrate Layer-2 scaling solutions, Zero-Knowledge Proofs (ZKPs), IPFS, and W3C Verifiable Credentials to improve the scalability, interoperability, and privacy of the blockchain-based solution. This review is limited to 30 English-based open-source studies and may introduce some subjectivity due to the involvement of predefined evaluation criteria for the local applicability assessment.

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